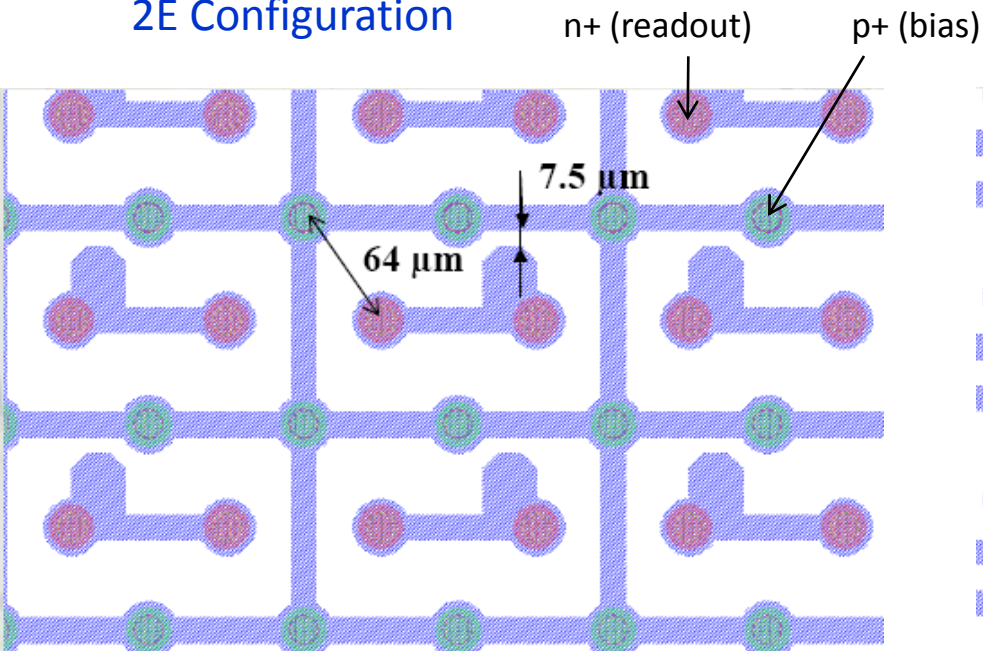


Preliminary results from 3D CMS pixel detectors

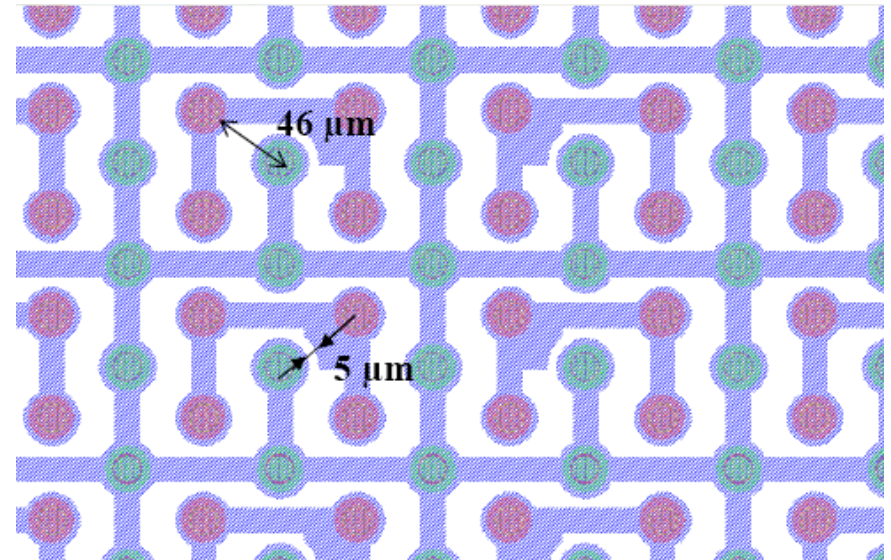
Ozhan Koybasi, Enver Alagoz, Ryan Rivera, Lorenzo Uplegger,
Marcos Turqueti, Kirk Arndt, Daniela Bortoletto, Simon Kwan, et al.

3D CMS Pixel Layouts

2E Configuration



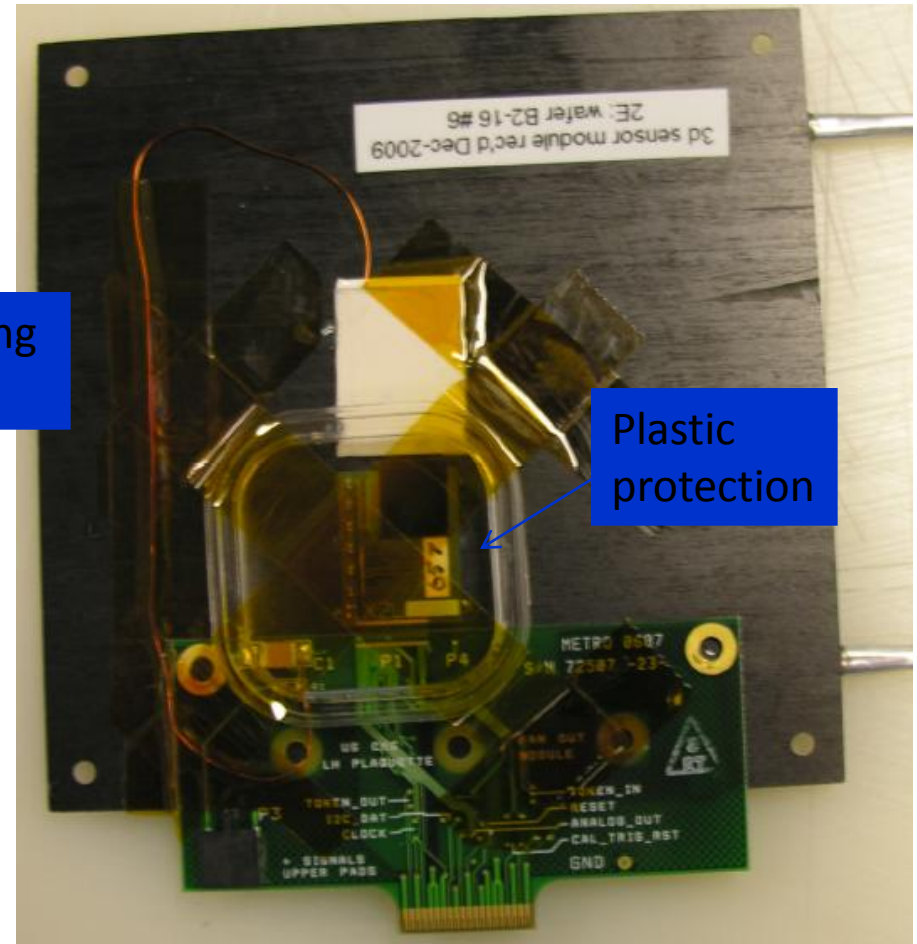
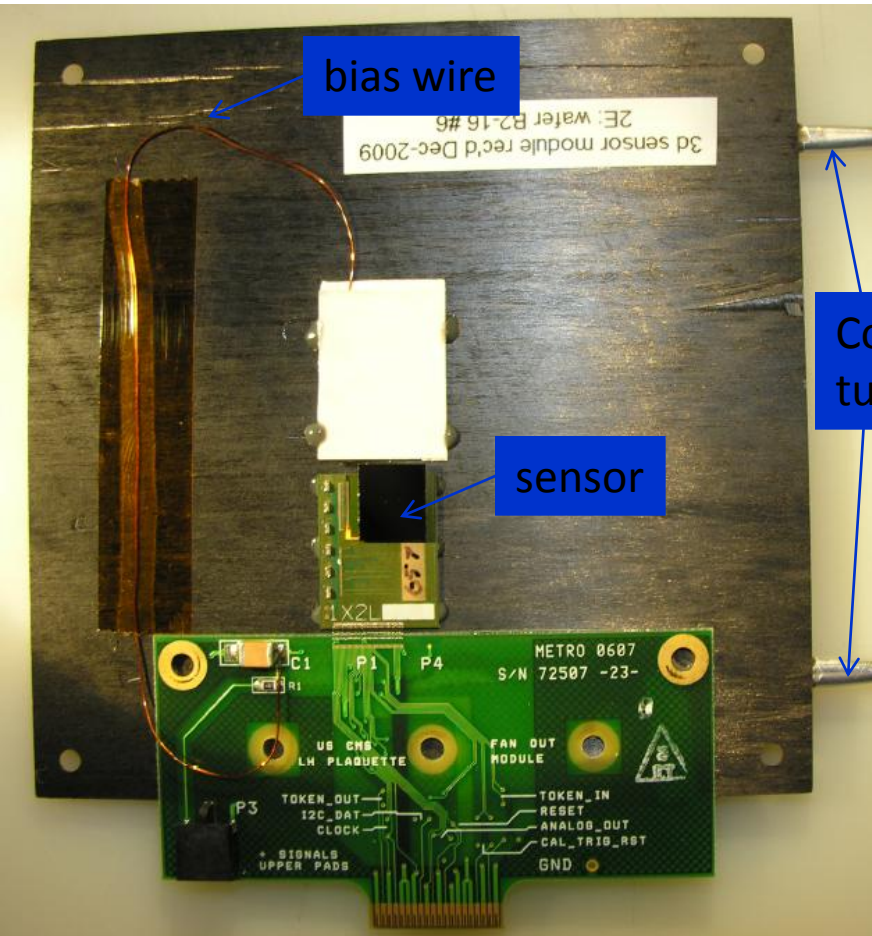
4E Configuration



Four 3D sensors mounted on plaquettes for testbeam:

- 2E_WB5_2 : 2E configuration, 280 μm substrate thickness
- 4E_WB5_8 : 4E configuration, 280 μm substrate thickness
- 4E_WB2-16_5 : 4E configuration, 200 μm substrate thickness
- 2E_WB2-16_2 : 2E configuration, 200 μm substrate thickness

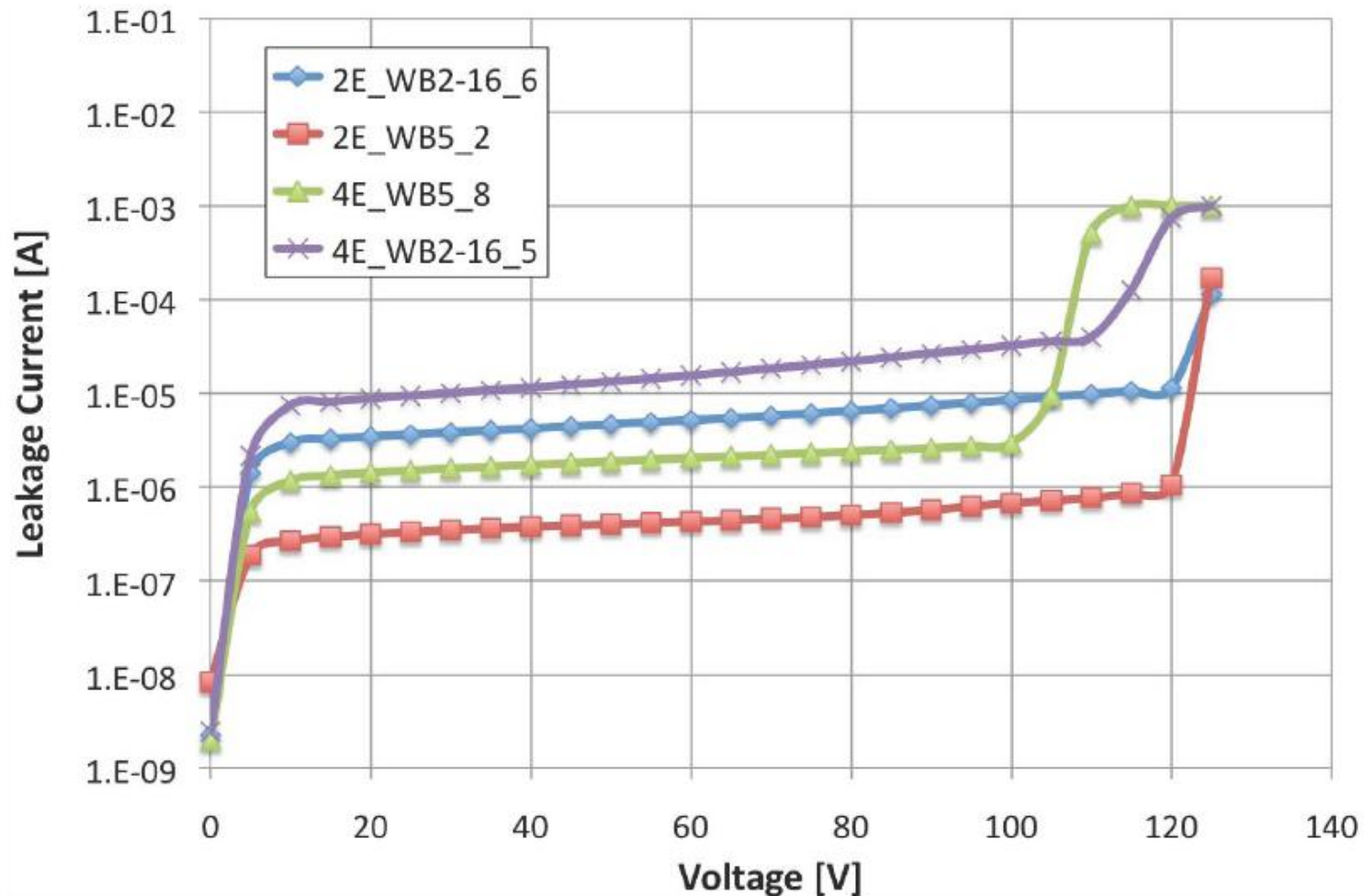
Assembly



- Support wafer made wire-bonding challenging (especially high voltage wiring)
- Sensors mounted on carbon fiber plates (0.5 mm thick)
- Cooling was done by a chiller
- Sensor temperature measurement:
an RTD placed on the carbon fiber (cooling tubes side): $\Delta T = 6^\circ \text{C}$

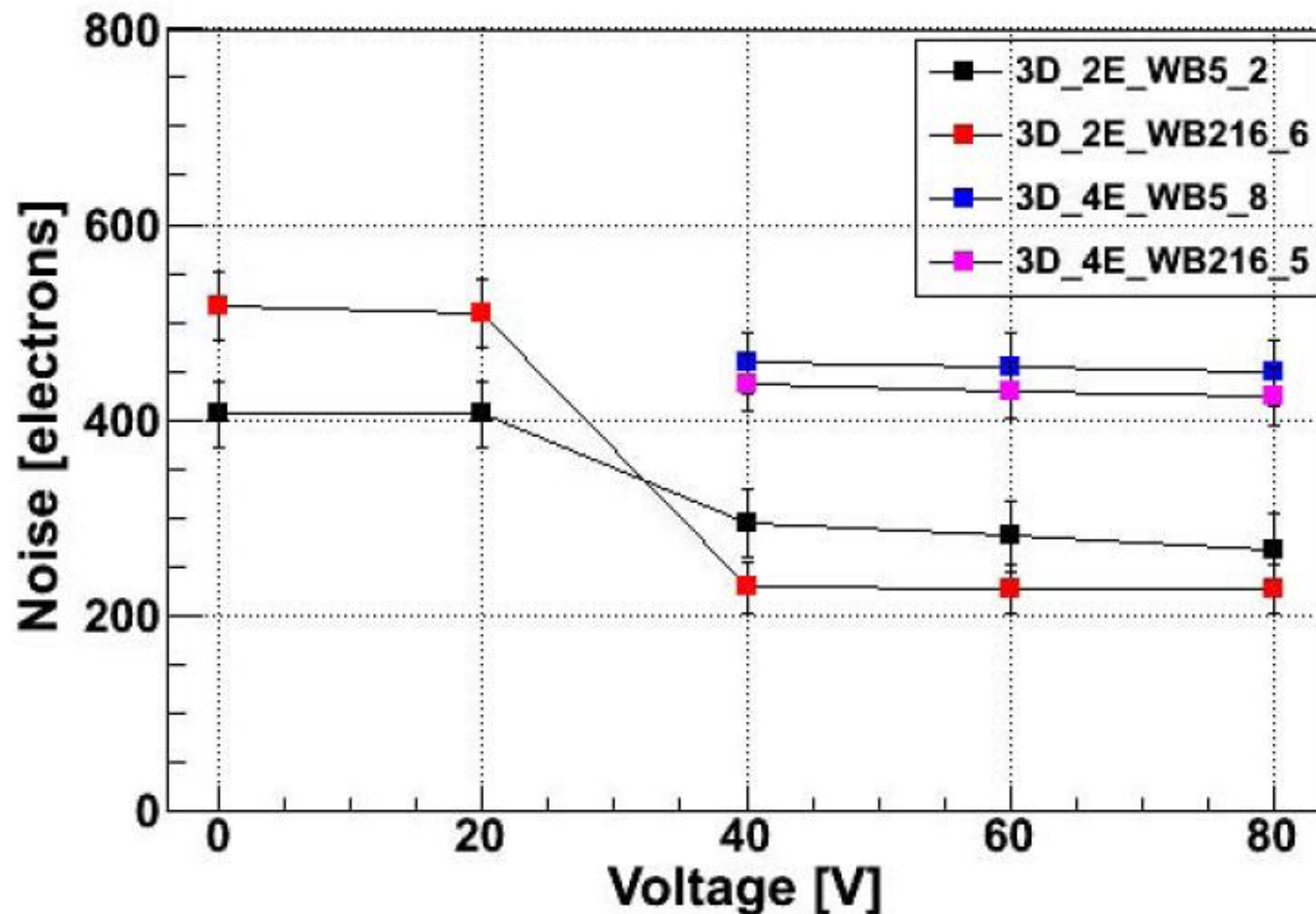
I-V Characteristics

- Measured at room temperature



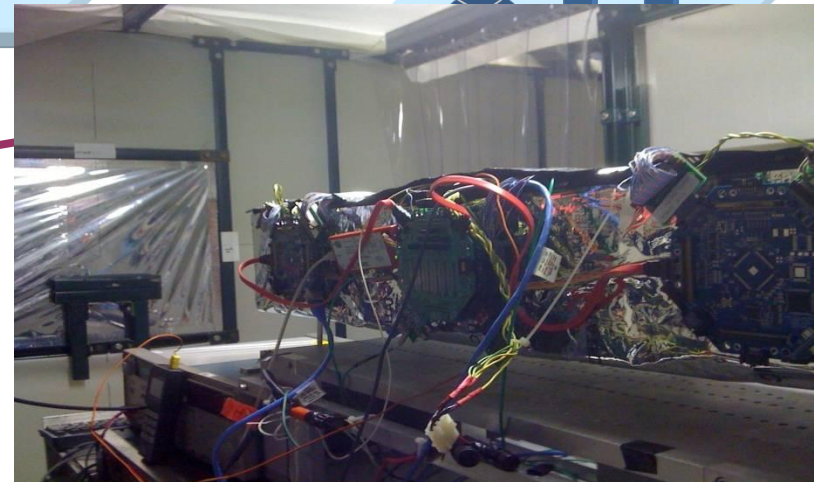
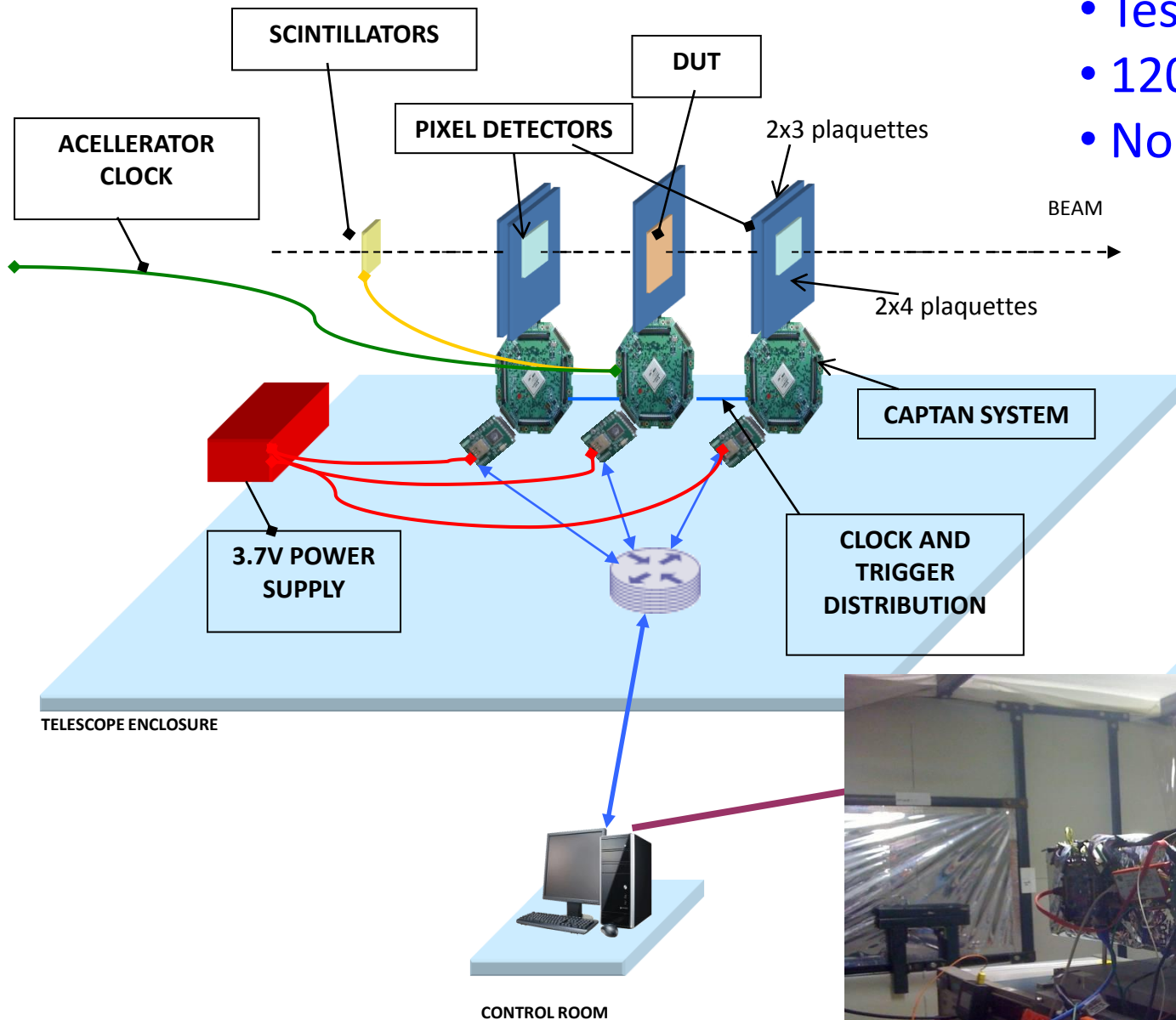
Noise

- Measured at room temperature
- Unable to measure noise at $V_{\text{bias}} < 40\text{V}$ for 4E sensors



Test beam setup at FNAL

- Test beam at FNAL
- 120 GeV protons
- No B field

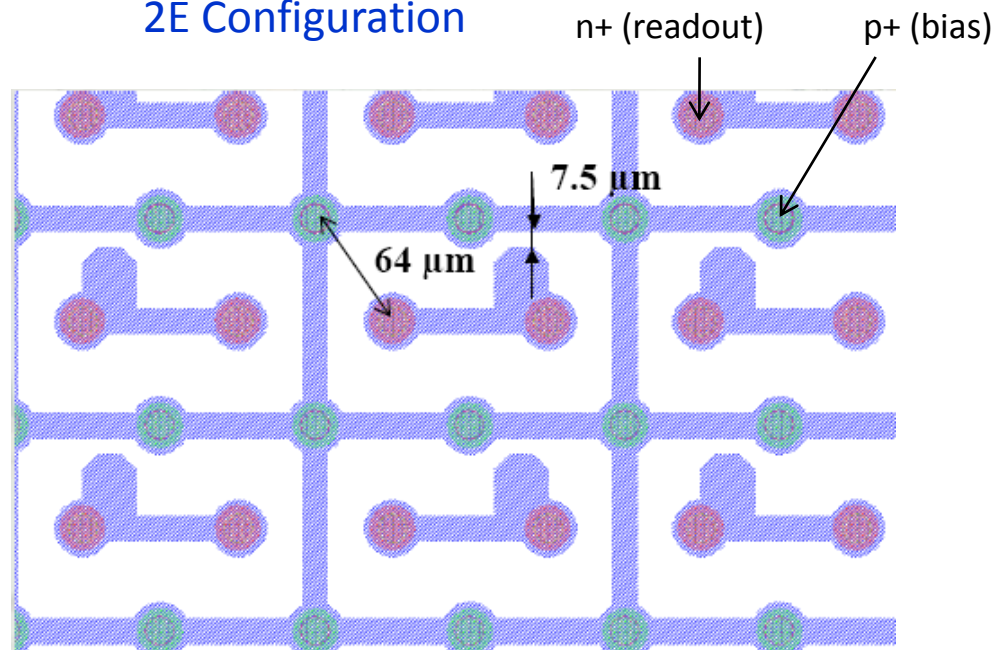


Beam Test Results

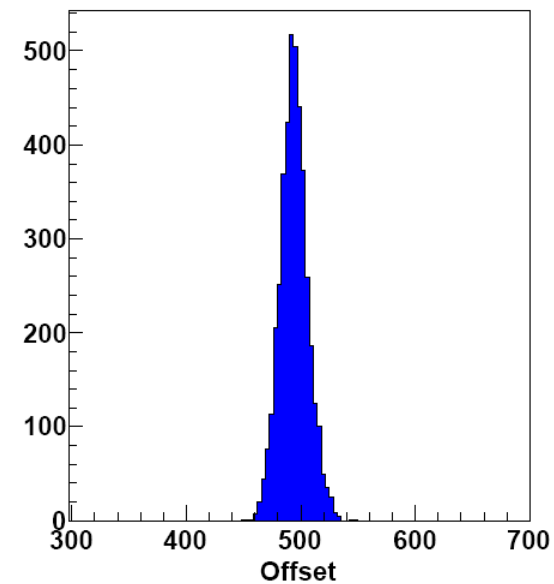
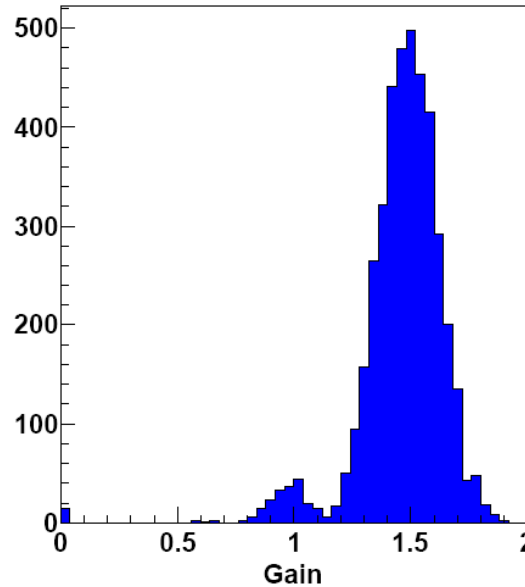
Sensor : 2E_WB5_2

280 μm substrate thickness

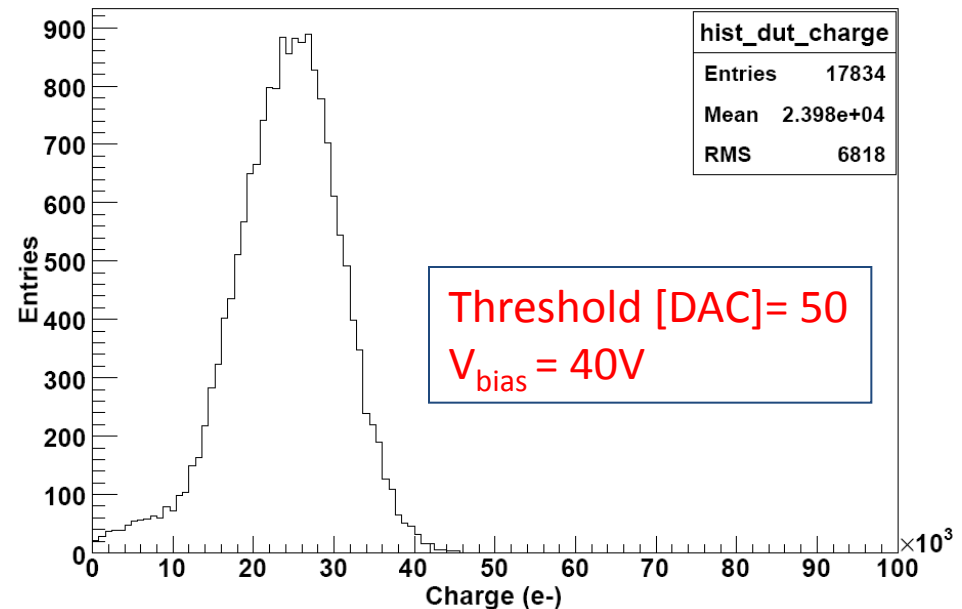
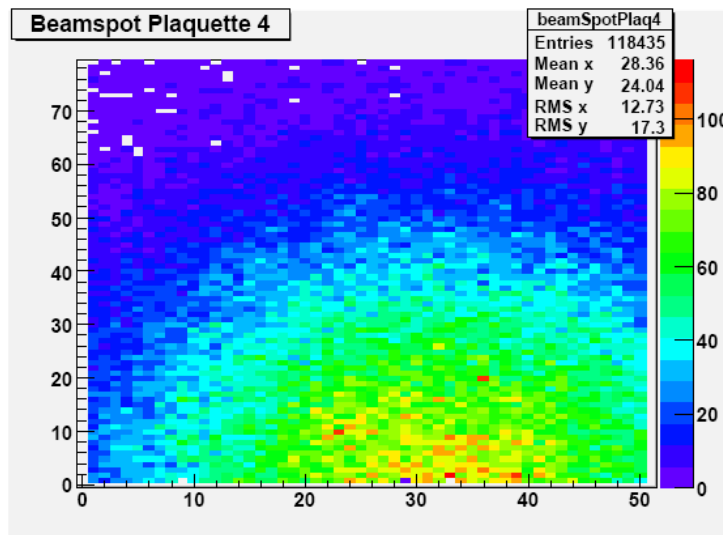
2E Configuration



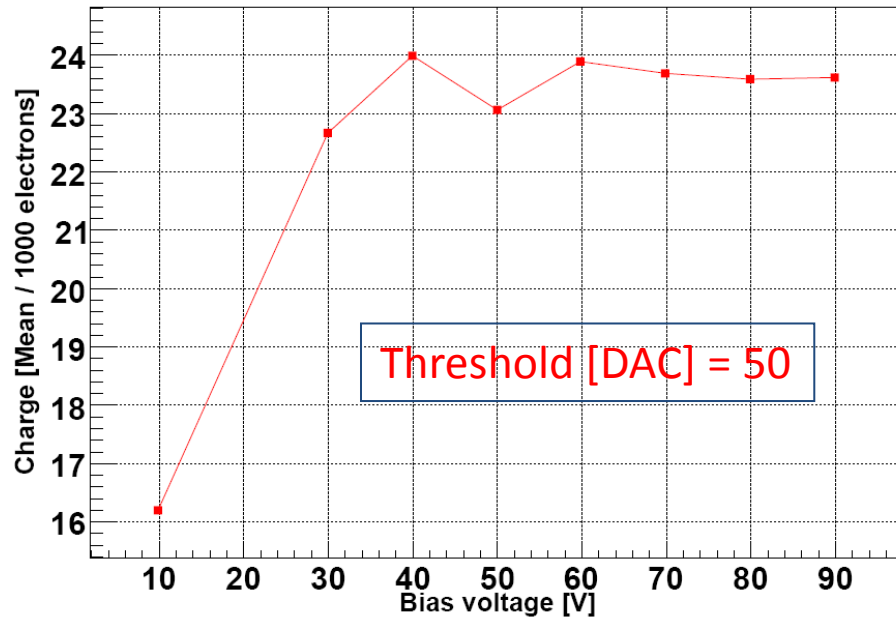
- Gain calibration done
- ADC to electron conversion:
 $V_{cal}^* [DAC] = ADC \times gain - offset$
 $Charge (e^-) = V_{cal} \times 65.5 - 410$
 - * 1 Vcal [DAC] = 65.5 electrons
- $T \approx 11^\circ C$ on carbon fiber
 (estimated to be $6^\circ C$ higher
 on the sensor)



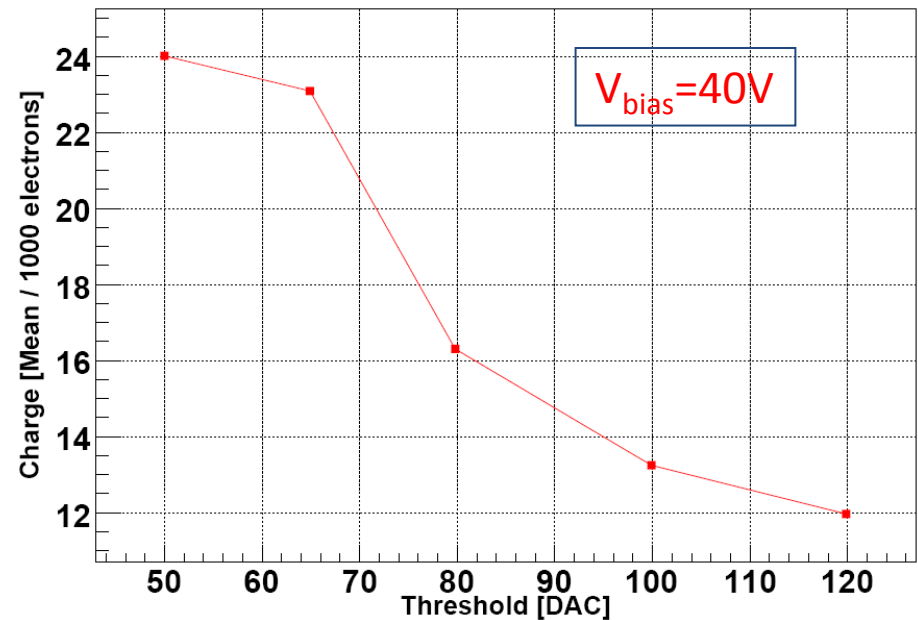
Beam spot on 3D



Charge collection



- Each point is charge distribution mean
- Convolved Landau and Gaussian fit to be done later
- Bias scan done only at Threshold [DAC] = 50

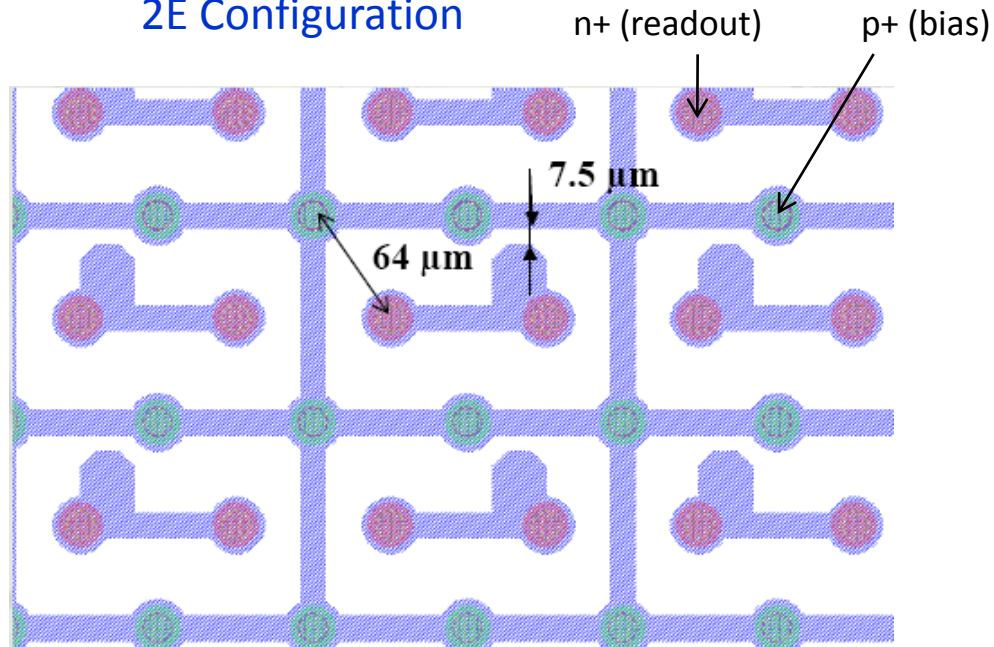


Beam Test Results

Sensor : 2E_WB2-16_6

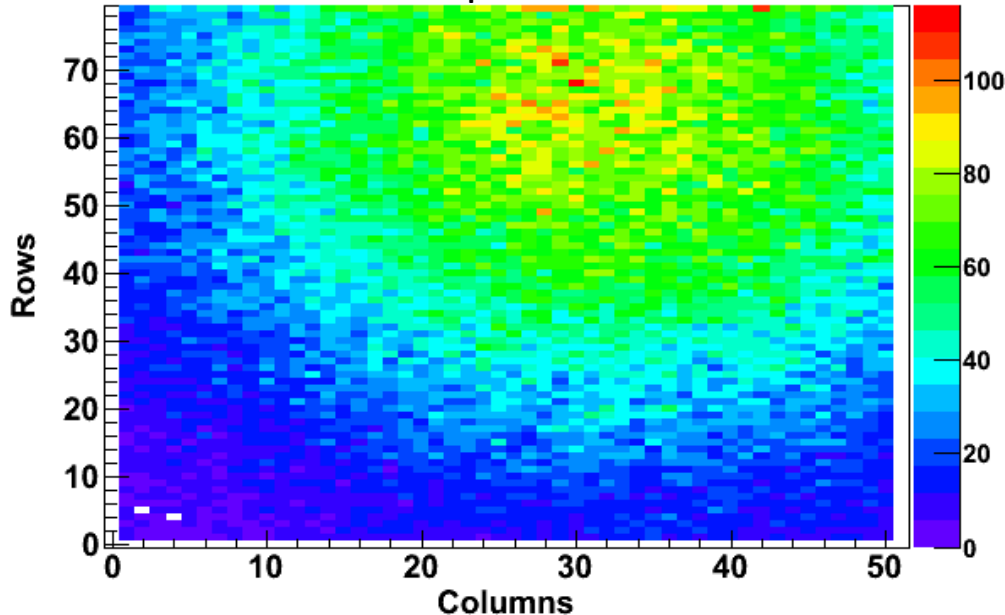
200 μm substrate thickness

2E Configuration

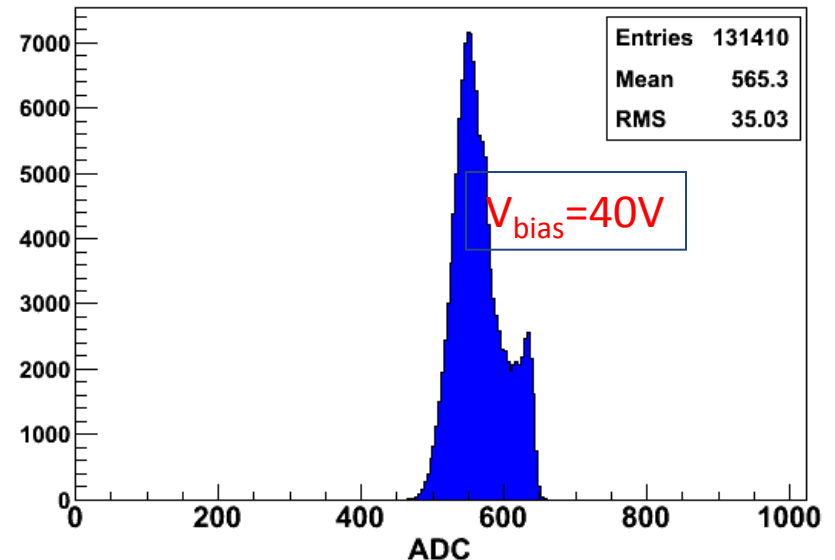


- Gain calibration was wrong: it has to be done again
- Detector data still requires further studies

Beam spot on 3D



ADC distribution



Summary

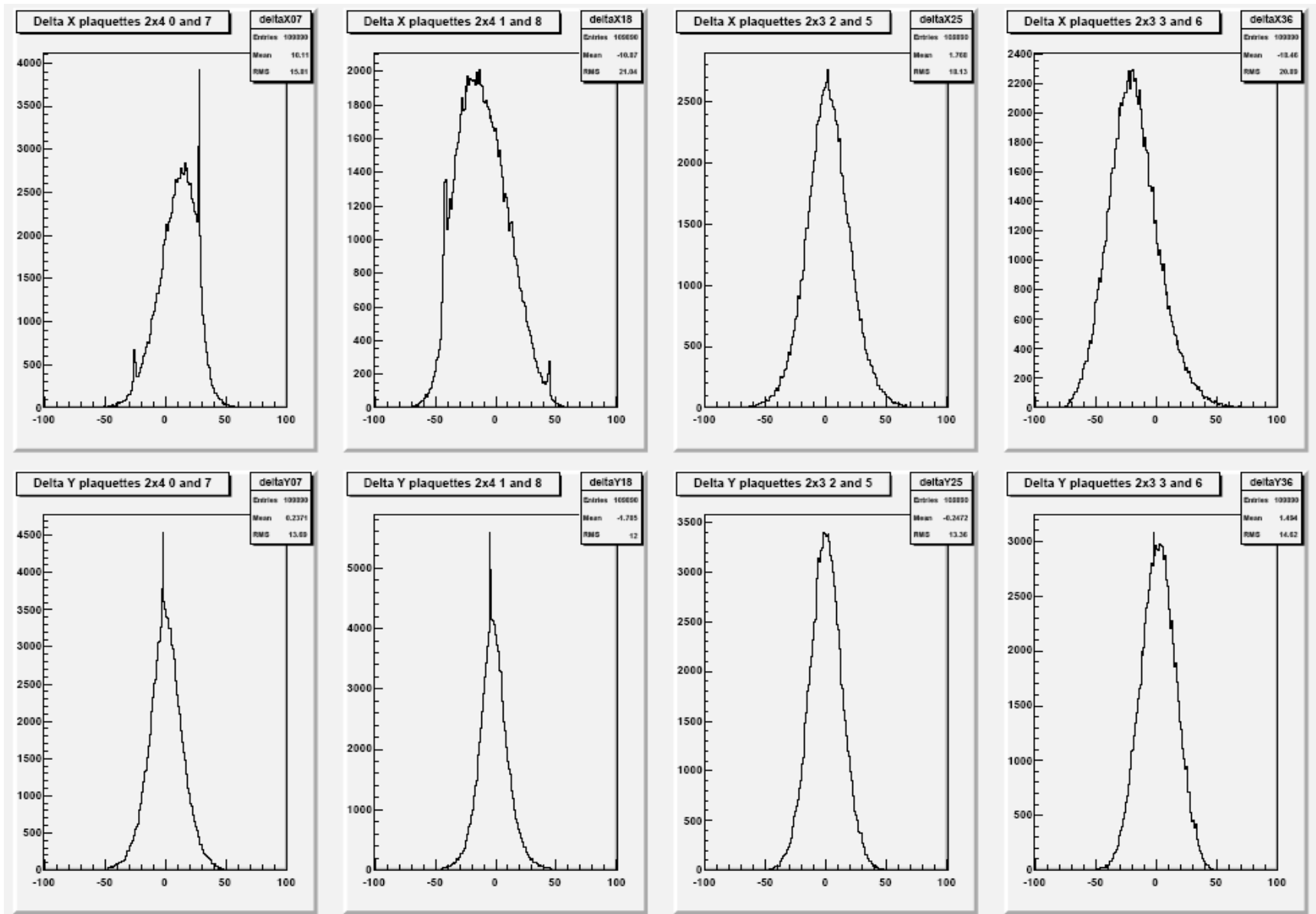
- Four 3D sensors received and wire bonded
- Lab characterization done
- 3D sensor assembled for the testbeam
- Sensors tested at FNAL with 120 GeV protons
- Bias and threshold scans performed
- 2Es worked and 4Es failed

Next:

- Further analysis
- Gain calibration and charge collection with a radioactive source setup at Purdue

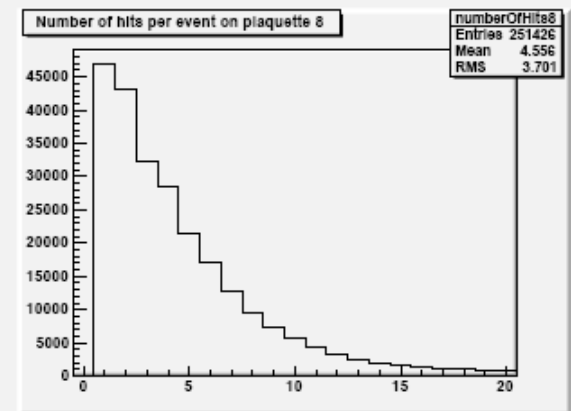
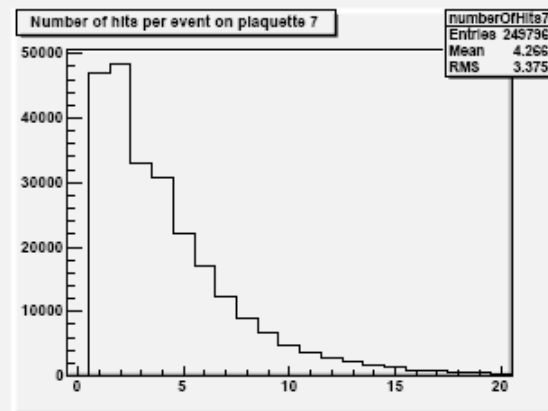
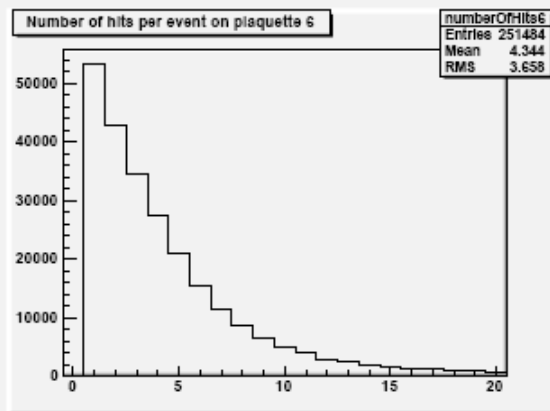
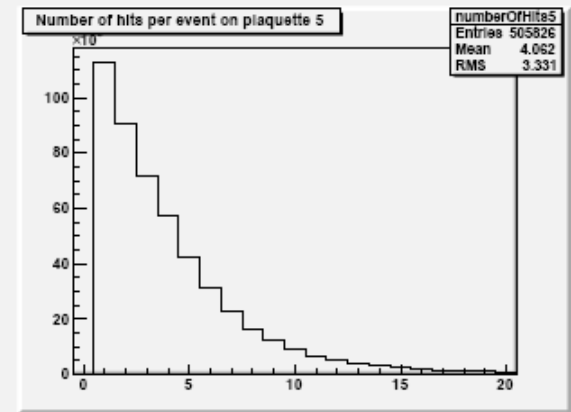
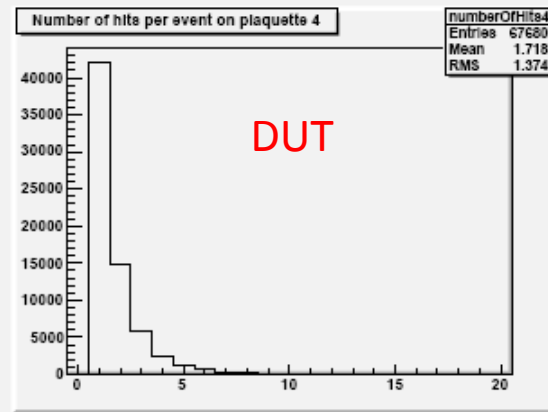
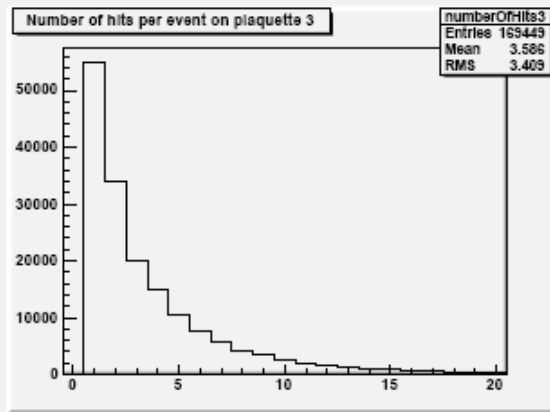
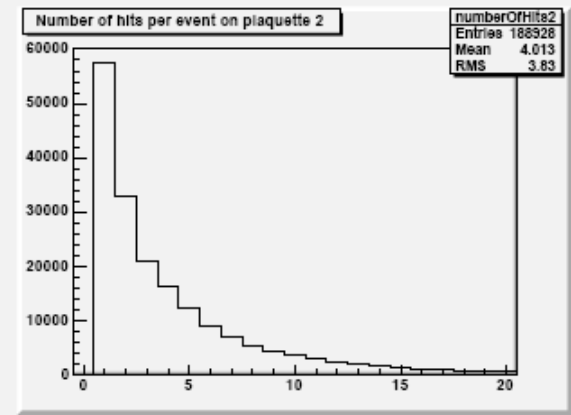
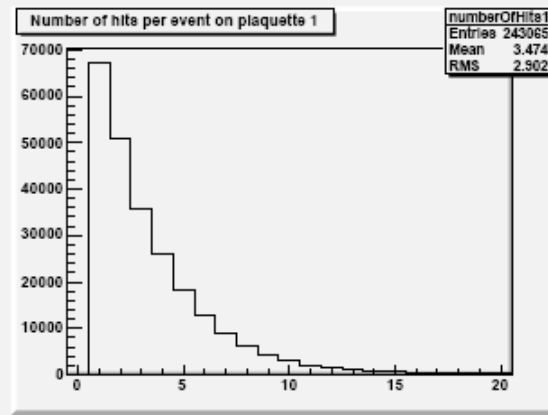
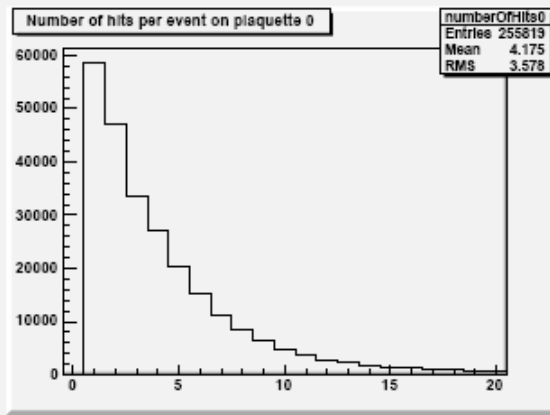
BACKUP SLIDES

Correlation between planes

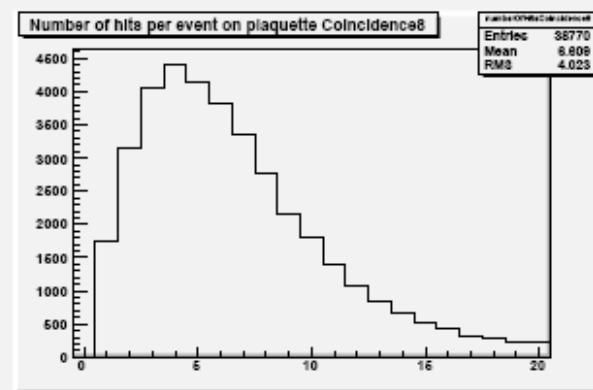
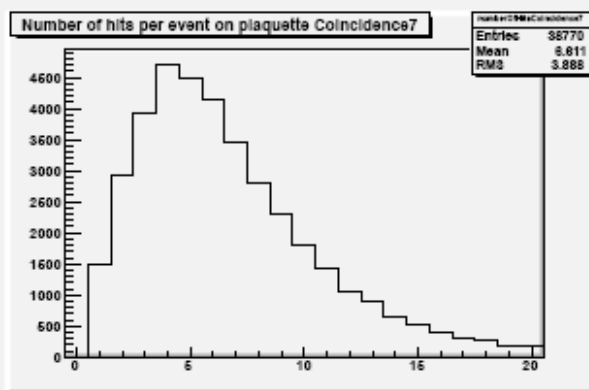
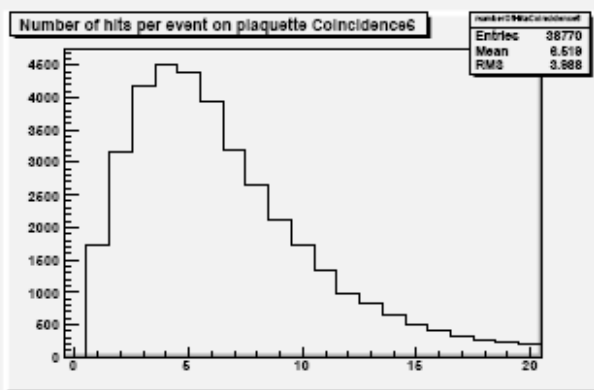
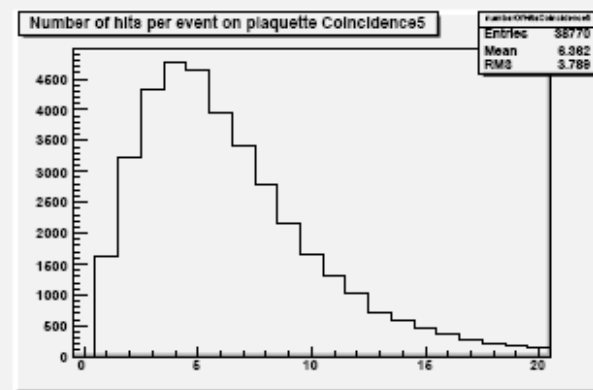
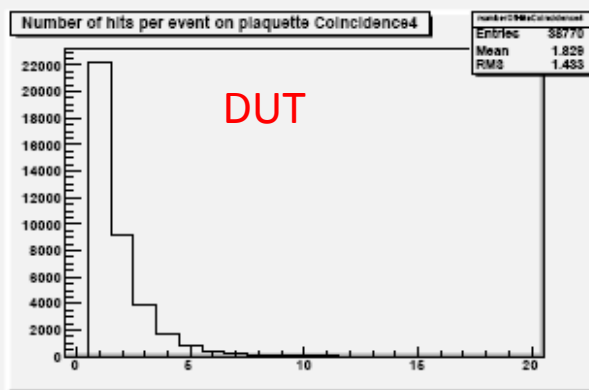
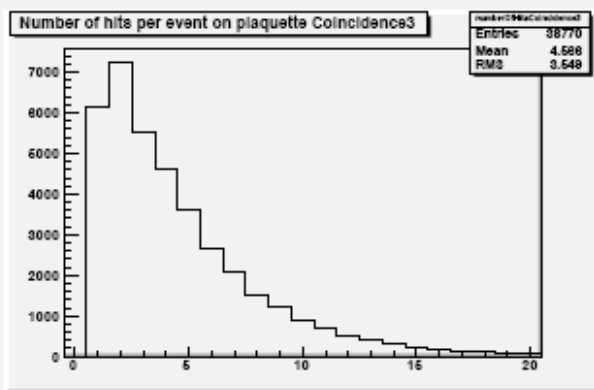
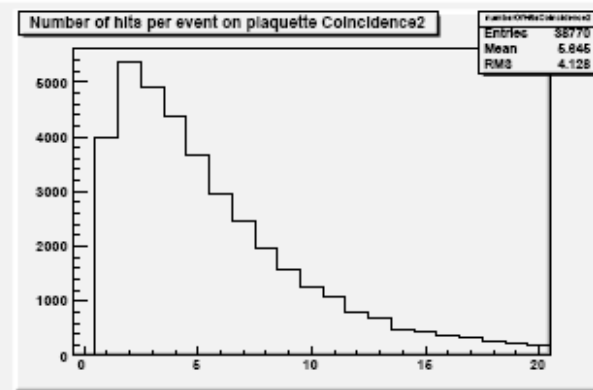
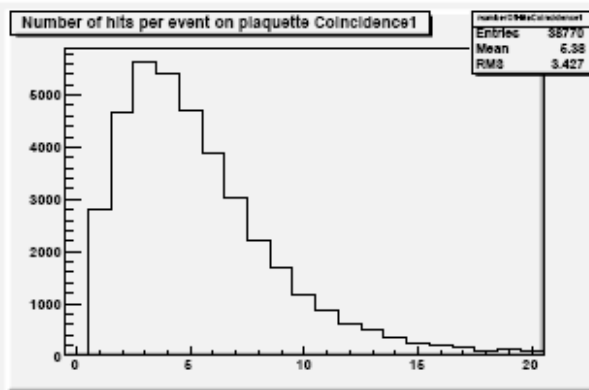
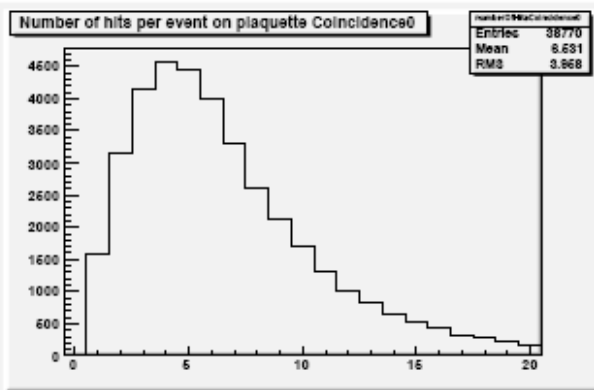


Threshold [DAC]= 50, $V_{bias} = 60V$

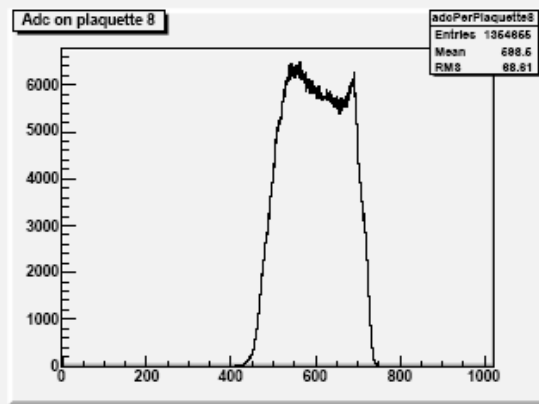
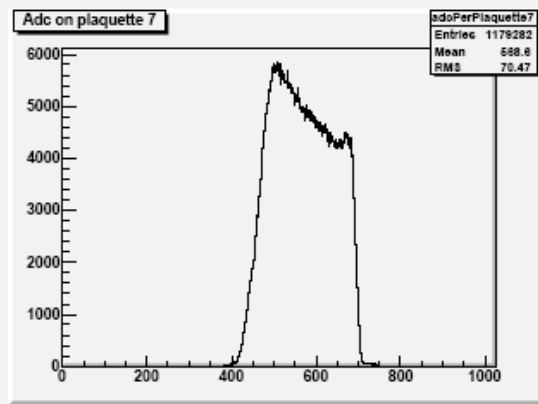
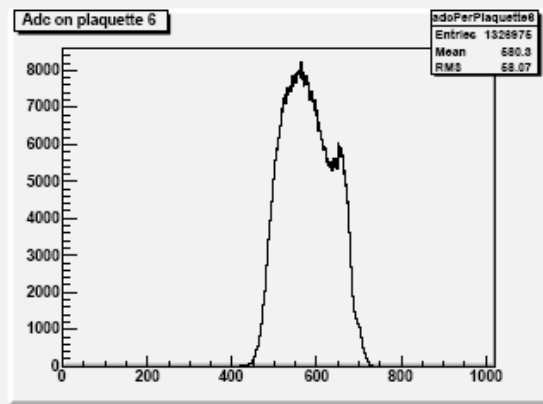
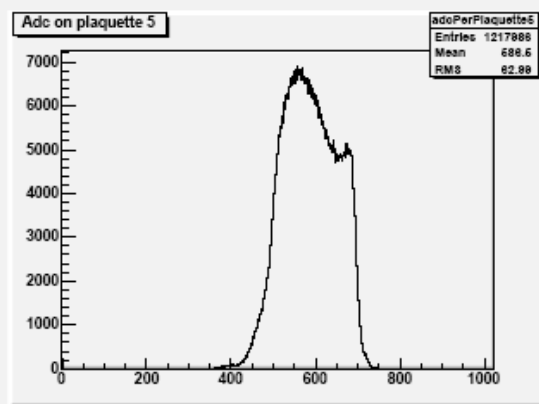
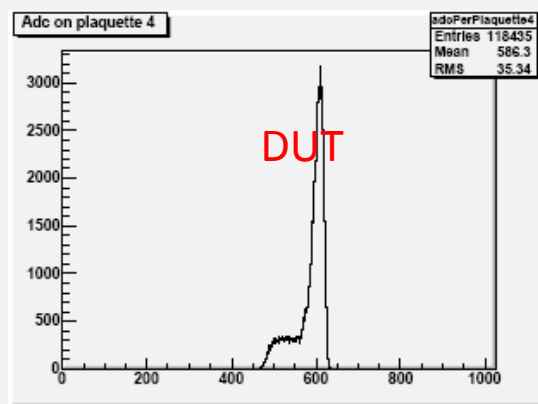
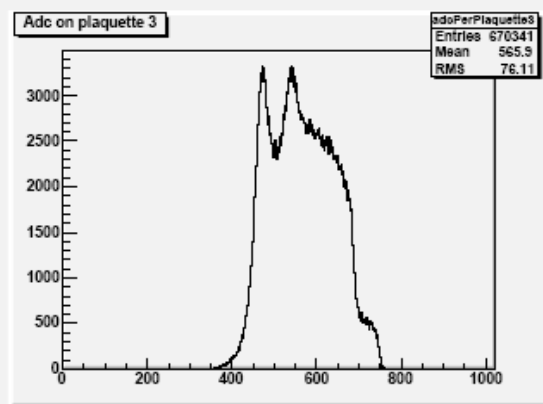
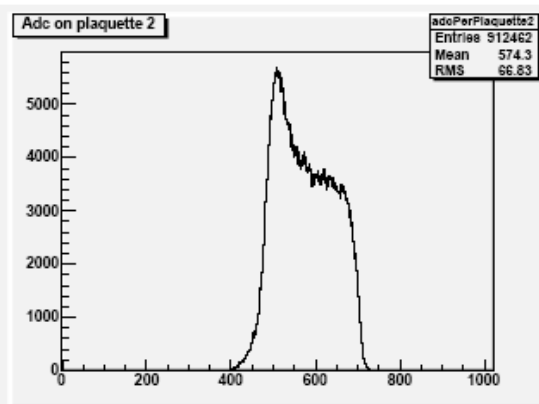
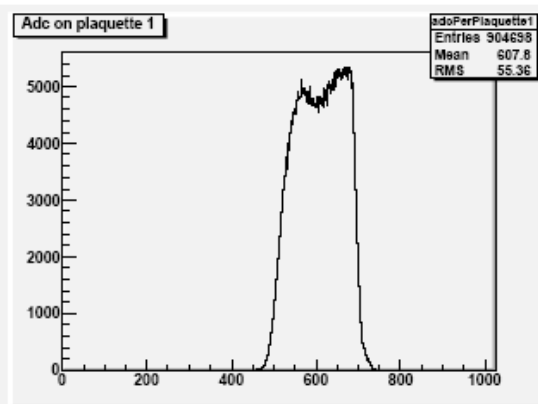
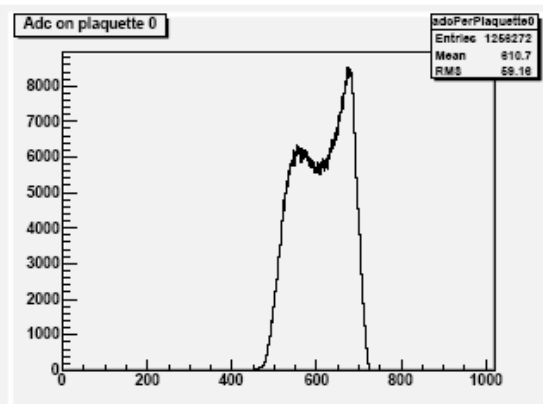
Sensor : 2E_WB5_2



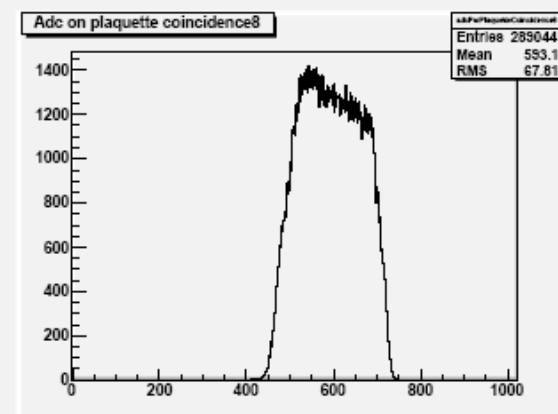
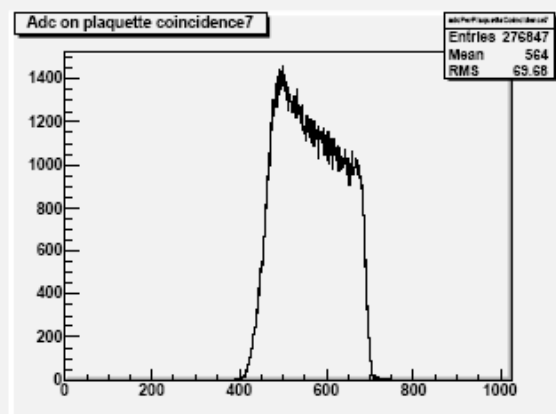
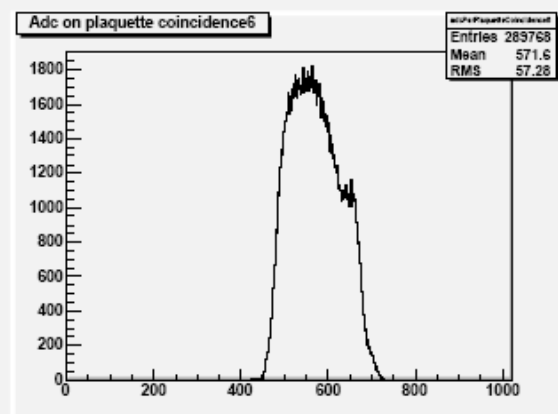
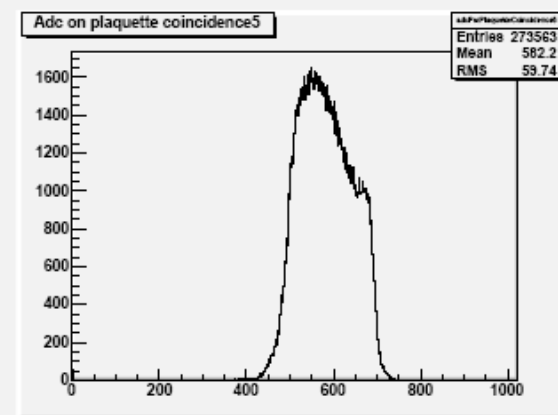
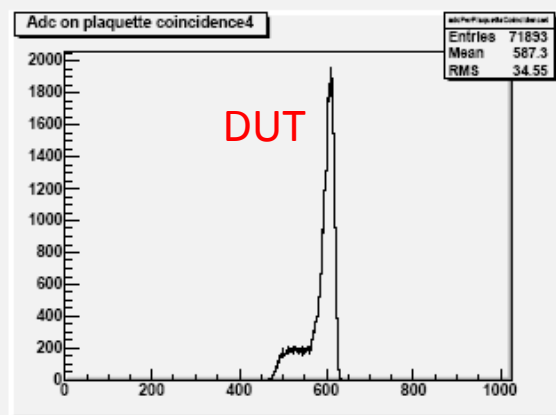
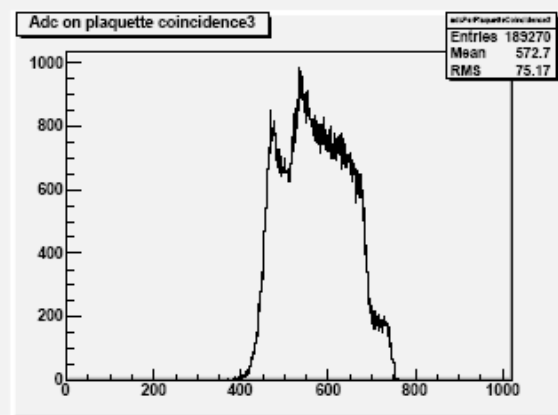
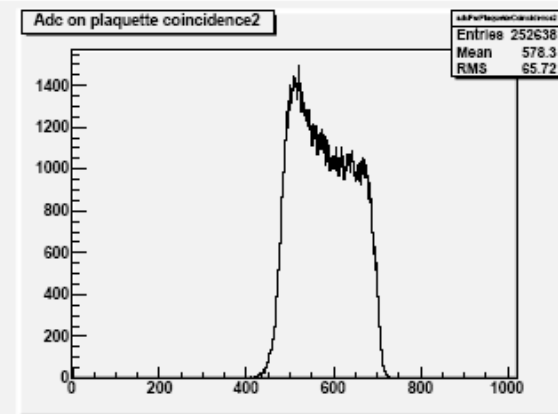
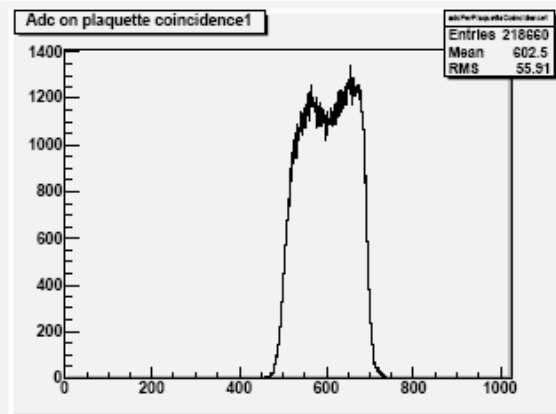
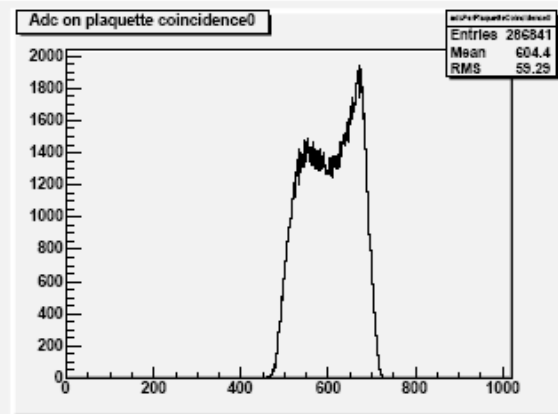
Threshold [DAC]= 50, $V_{\text{bias}} = 60\text{V}$



Threshold [DAC]= 50, $V_{bias} = 60V$

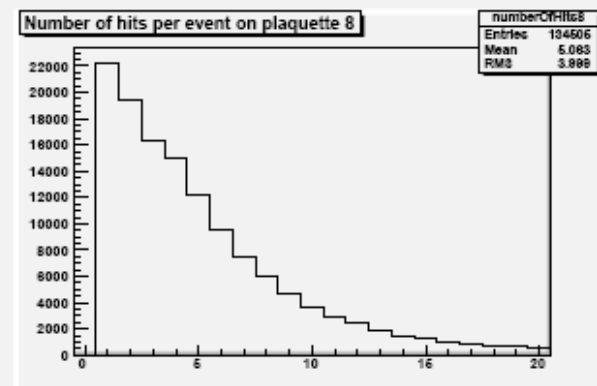
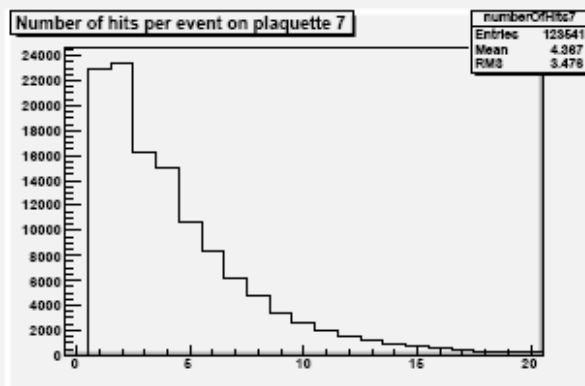
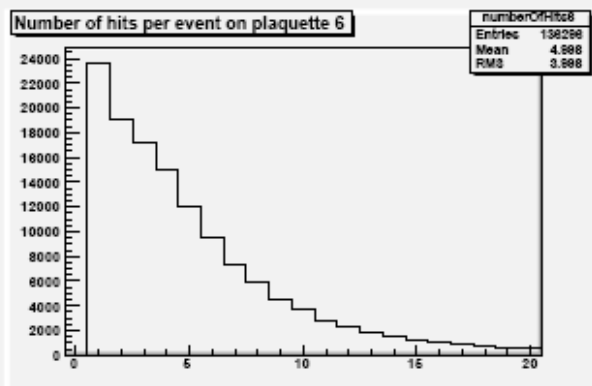
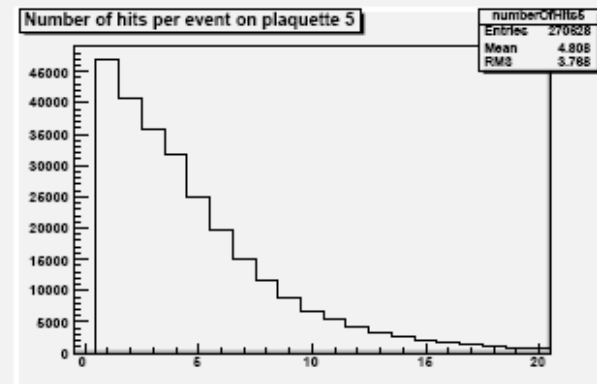
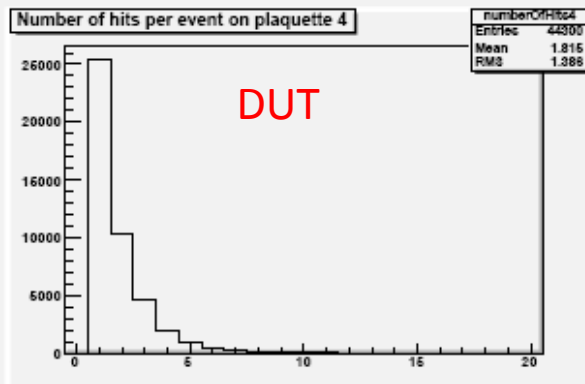
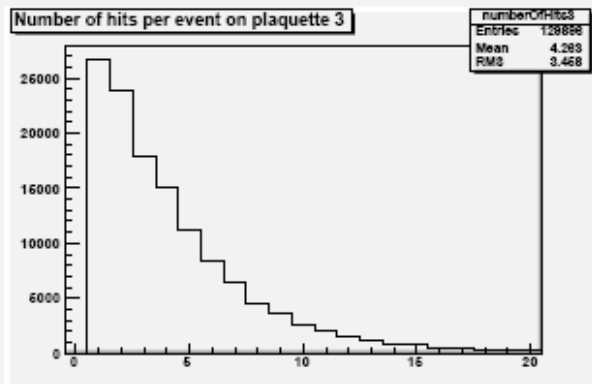
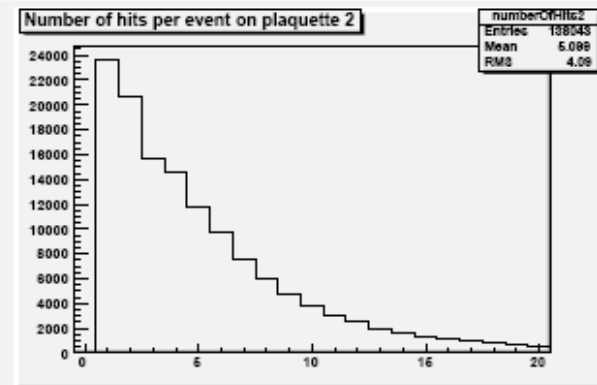
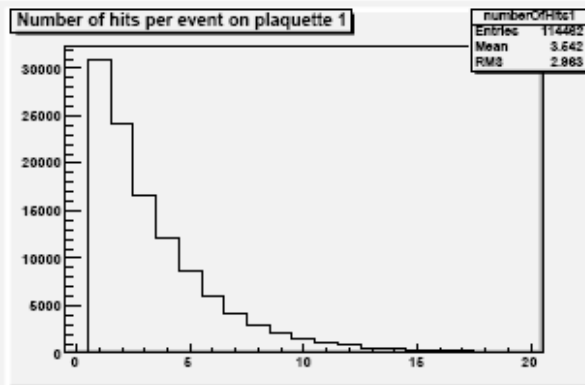
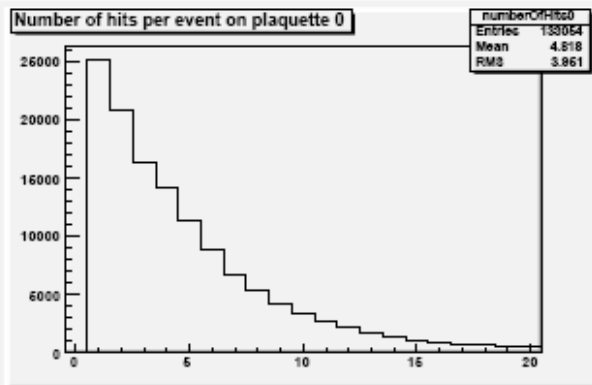


Threshold [DAC]= 50, $V_{\text{bias}} = 60\text{V}$

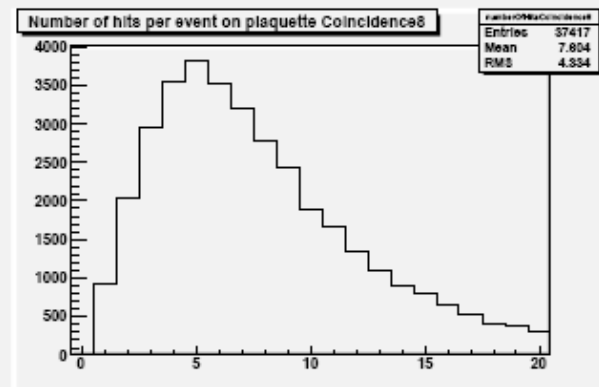
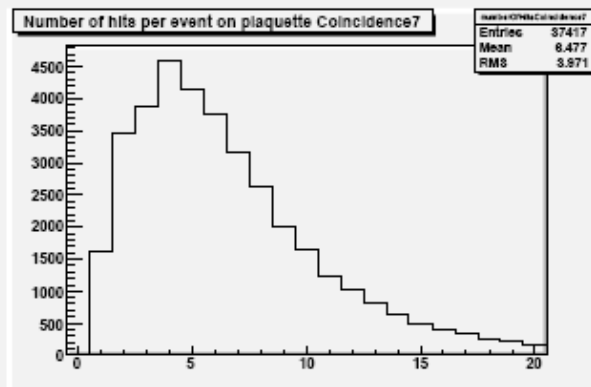
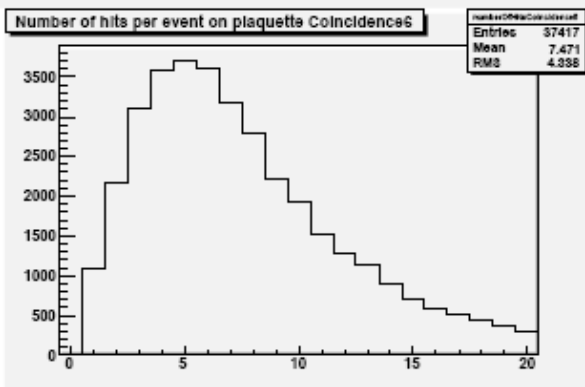
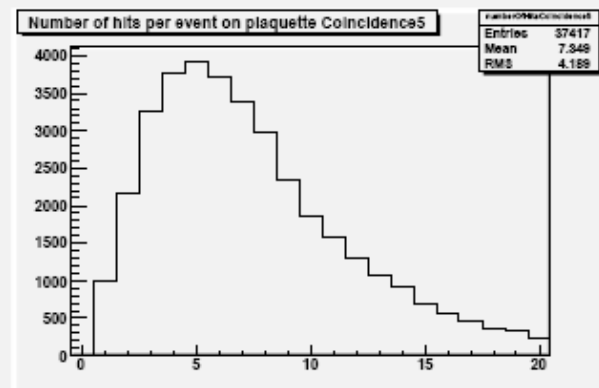
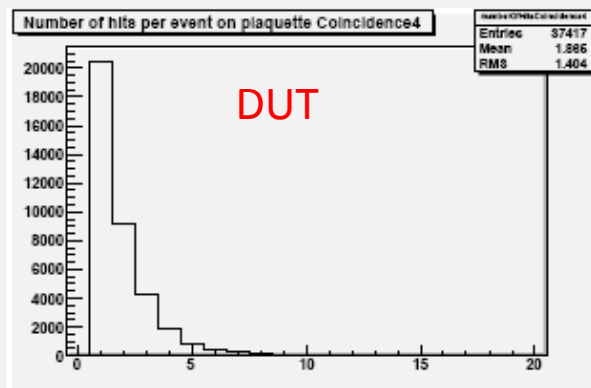
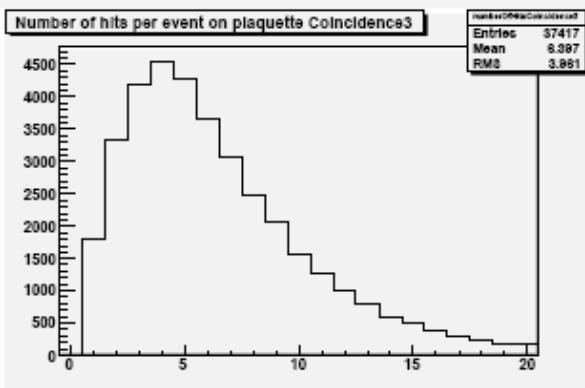
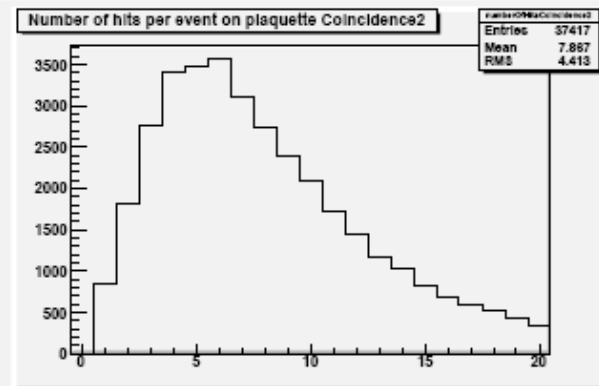
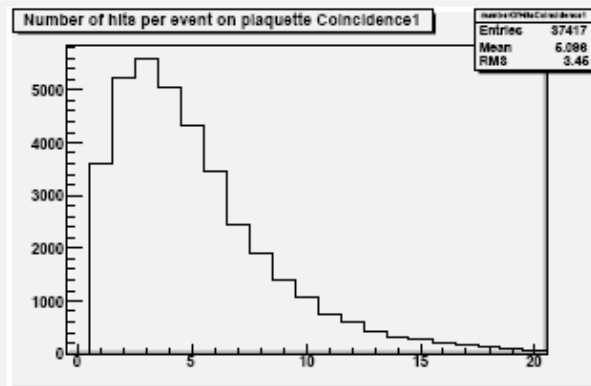
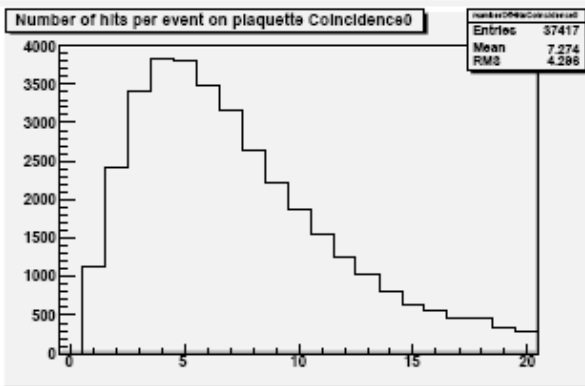


Threshold [DAC]= 50, $V_{bias} = 60V$

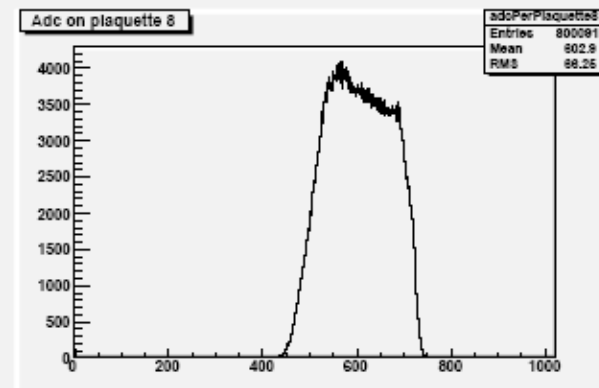
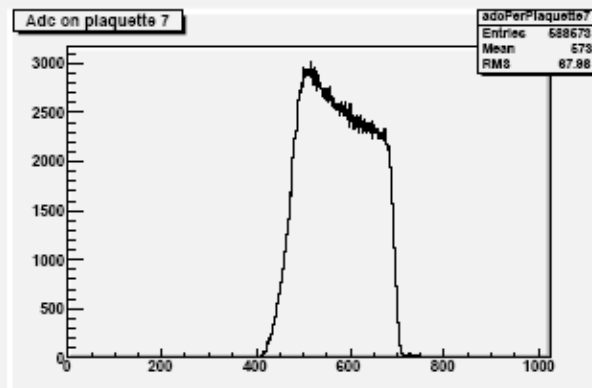
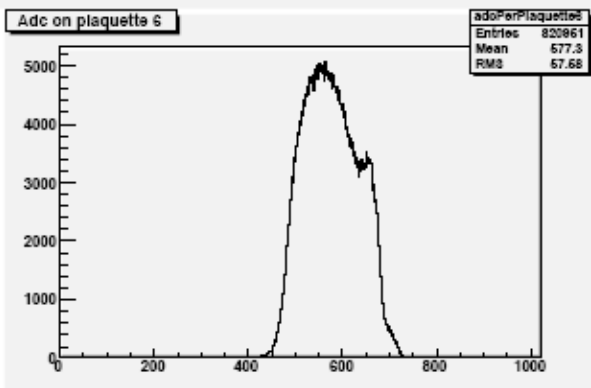
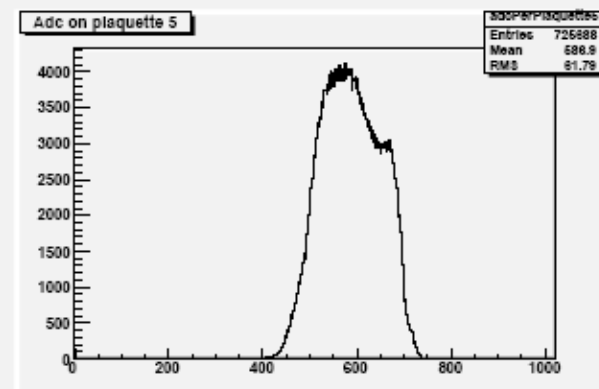
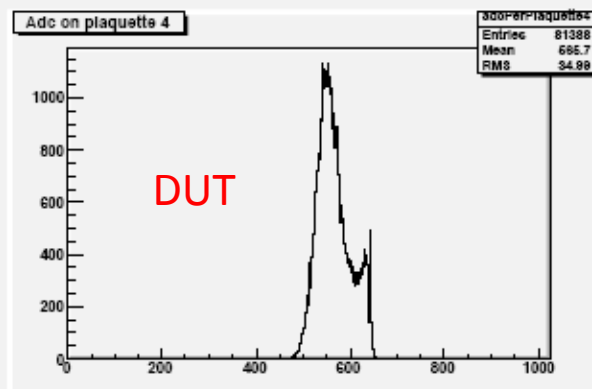
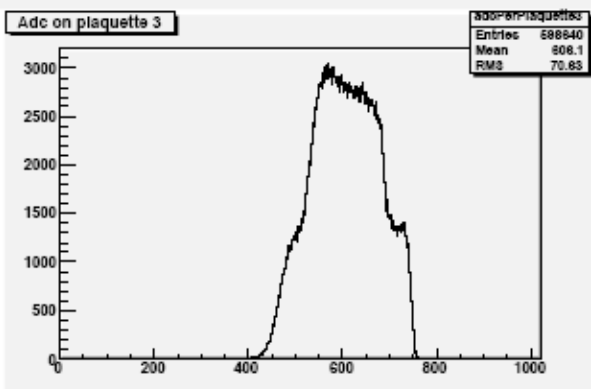
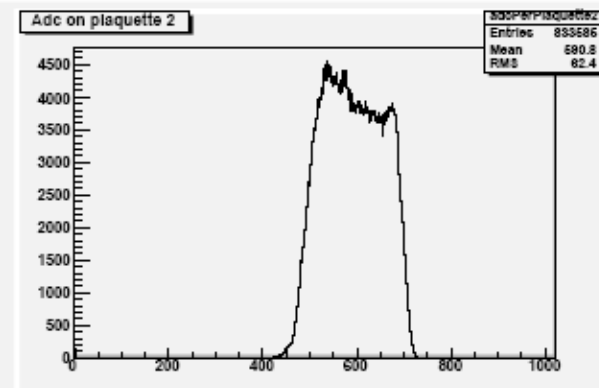
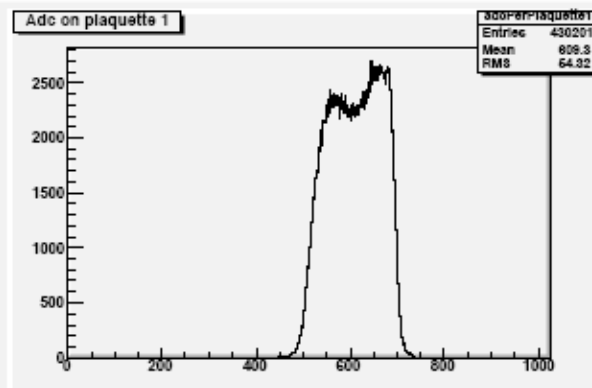
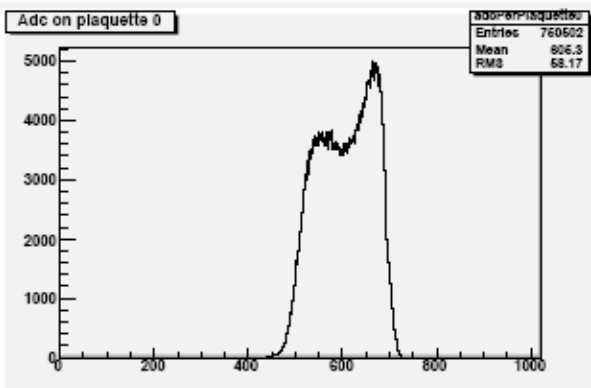
Sensor : 2E_WB2-16_6



Threshold [DAC]= 50, $V_{\text{bias}} = 60\text{V}$



Threshold [DAC]= 50, $V_{\text{bias}} = 60\text{V}$



Threshold [DAC]= 50, $V_{\text{bias}} = 60\text{V}$

